In the United States Court of Federal Claims

No. 03-2623C

(Filed: April 23, 2013)

SYSTEM FUELS, INC. and ENTERGY ARKANSAS, INC., **Plaintiff,** **v.** **UNITED STATES,** **Defendant.**	Post-trial decision in a remanded case involving the Standard Contract for pickup of spent nuclear fuel; application of the 1987 industry-wide acceptance rate; causation; costs of mitigation for partial breach; avoided costs

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Scott R. Damelin, Trial Attorney, Commercial Litigation Branch, Civil Division, United States Department of Justice, Washington, D.C., for defendant. With him were Marian E. Sullivan, Senior Trial Counsel, James P. Connor, Lisa L. Donahue, and Luke A.E. Pazicky, Trial Attorneys, Commercial Litigation Branch, Civil Division, United States Department of Justice. On the briefs were Stuart Delery, Principal Deputy Assistant Attorney General, Jeanne E. Davidson, Director, and Bryant G. Snee, Deputy Director. Of counsel was Jane K. Taylor, Office of General Counsel, United States Department of Energy, Washington, D.C.

OPINION AND ORDER

LETTOW, Judge.

The Department of Energy ("DOE") has failed to fulfill its contractual obligation to collect and dispose of spent nuclear fuel ("SNF") and high-level radioactive waste ("HLW") generated at the two-unit Arkansas Nuclear One ("ANO") power plant located at Russellville, Arkansas. Plaintiffs, System Fuels, Inc. and Entergy Arkansas, Inc. (collectively "System Fuels," or "plaintiffs"), own the units and seek damages for the government's breach of contract. The court previously granted System Fuels summary judgment on liability for a partial breach of contract, *see System Fuels, Inc. v. United States*, 65 Fed. Cl. 163, 177 (2005) ("*System Fuels I*"), and the court determined damages in a subsequent post-trial decision, *see System Fuels, Inc. v.*

United States, 79 Fed. Cl. 37 (2007) ("*System Fuels III"*),[1] *recons. denied*, 79 Fed. Cl. 182 (2007) ("*System Fuels IV"*), *aff'd in part, rev'd in part, System Fuels, Inc. v. United States*, 457 Fed. Appx. 930 (Fed. Cir. 2012) ("*System Fuels V*").

The court's decision awarded $48,651,728 in damages, using an industry-wide acceptance rate of 3,000 MTU per year ("the 3000 MTU rate" or "3000 rate") to calculate the amount of spent nuclear fuel which would have been removed by DOE, had it performed on the contract. *See System Fuels III*, 79 Fed. Cl. at 55, 74.[2] On appeal, the Federal Circuit affirmed in part but determined that the 3000 MTU rate was not the appropriate rate; rather, the court should have applied the acceptance rate identified in DOE's 1987 Annual Capacity Report ("the 1987 rate"). *System Fuels V*, 457 Fed. Appx. at 934.[3] The case was remanded to this court for analysis of causation and damages employing the 1987 rate.

The remand trial occurred over seven days in October and November of 2012. The bulk of the damages awarded in the original trial were not contested at the remand trial, as neither party contended that they were affected by the rate change. *See* DX 538 at 9 (Report of Robert Peterson, an expert testifying on behalf of the government) (noting $34,051,573 of uncontested damages). The parties focused during the remand trial on four specific areas of plaintiffs' mitigation of defendant's partial breach where damages might have been altered. Post-trial briefing has now concluded and closing argument was held on March 18, 2013. The case is ready for disposition.

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[1]An intervening decision, *System Fuels, Inc. v. United States*, 73 Fed. Cl. 206 (2006) ("*System Fuels II"*), resolved a set of discovery disputes that had arisen during the parties' preparatory steps for the trial on damages.

[2]The 3000 MTU rate was advocated by System Fuels and adopted by the court in the original trial. *System Fuels III*, 79 Fed. Cl. at 55-57. Under this rate, DOE would have honored its statutory obligation to make its first collection of SNF at nuclear power plants commencing in January 1998. The first collection would have occurred at ANO in 2001, ramping up over five years to an eventual steady-state performance of 3,000 MTU/year. *Id.* at 55.

[3]The 1987 rate is described in the "Illustrative Waste Acceptance Schedule for the First 10 Years of Facility Operation" section of the June 1987 Annual Capacity Report issued by DOE. *See Pacific Gas and Elec. Co. v. United States*, 536 F.3d 1282, 1290 (Fed. Cir. 2008). Under this rate, DOE proposed to accept SNF and HLW industry-wide at a stepped up rate that started at 1,200 MTU/year in 1998, increasing to 2,000 MTU/year by 2003, and then to 2,650 MTU/year from 2004 through 2007. *Id*. The first pick-up to which System Fuels was entitled under the 1987 rate would have occurred in 1999. *See* PX 501 at 2 (Supplemental Report of Eileen Supko, an expert testifying on behalf of System Fuels) (modeling the amount and timing of ANO's acceptance rights under the 1987 rate).

FACTS[4]

A. The Nuclear Waste Policy Act

During the normal course of operation, nuclear reactors produce radioactive waste in the form of SNF and HLW. To "avoid the inefficient and potentially unsafe prospect of allowing individual utilities to recycle or dispose of their own [SNF]," Congress enacted the Nuclear Waste Policy Act of 1982, Pub. L. No. 97-425, 96 Stat. 2201 (Jan. 7, 1983) ("NWPA") (codified as amended at 42 U.S.C. §§ 10101-10270). The NWPA authorizes "the siting, construction, and operation of repositories" for storing SNF, and the subsequent use of those repositories for an indeterminate period. 42 U.S.C. §§ 10131(a)(4), (b)(1), 10221(a).

Under the NWPA, DOE entered into a "Standard Contract for Disposal of Spent Nuclear Fuel and/or High-Level Radioactive Waste" ("the Standard Contract" or "contract") with individual operators of nuclear plants. *See, e.g.*, DX 1 (Pls.' Standard Contract).[5] The terms of the Standard Contract called for payment of two fees by the utility: first, a one-time fee based on energy generated and sold before April 7, 1983, and, second, a continuing fee based on the amount of energy produced after that date. *Id.*, Art. VIII. In exchange, DOE committed to removing SNF and HLW from the signatory plant operators starting no later than January 31, 1998. *Id.*, Art. II. The precise dates and amounts of the SNF pickups are not specified in the Standard Contract, which simply states that DOE must claim the materials "as expeditiously as possible," and assures that DOE would issue annual acceptance priority rankings for SNF pickup starting on April 1, 1991. *Id.* at 1, Art. IV.B.5(a).

System Fuels entered into a Standard Contract with DOE on June 30, 1983. DX 1 (Pls.' Standard Contract). System Fuels has fully performed its obligations under the contract to date, and has been making payments on the one-time fee under the Standard Contract's payments-with-interest option. As of the expiration of the claim period in this case, June 30, 2006, the expected one-time fee totaled roughly $165 million. *System Fuels V*, 457 Fed. Appx. at 932. System Fuels has also maintained full payment of the continuing fee, at a rate of approximately $13 to $15 million per year (reaching a total of nearly $269 million as of the expiration of the claim period). *Id.* In contrast, as of the date of the remand trial, DOE has yet to perform a single pickup of SNF or HLW from ANO. 2012 Tr. 51:22 to 52:5 (Test. of Kenneth B. Metcalfe, an

[4]The recitation of facts supplements the court's earlier findings reported in *System Fuels III* at 79 Fed. Cl. at 40-51, and constitutes the court's principal findings in accord with Rule 52(a) of the Rules of the Court of Federal Claims ("RCFC"). Other findings of fact and rulings on questions of mixed fact and law are set out in the analysis.

[5]Plaintiffs' exhibits will be cited as "PX __," and defendant's exhibits will be cited as "DX __." Plaintiffs' demonstrative exhibits will be shown as "PRDX __," and defendant's demonstrative exhibits as "DRDX __."

expert testifying on behalf of plaintiff).[6] Thus, all SNF or HLW which should have been taken and stored by DOE under the Standard Contract instead remains the burden of System Fuels.

B. The ANO facility

The Arkansas Nuclear One power plant owned and operated by plaintiffs consists of two units, the first a Babcock & Wilcox reactor ("Unit 1") and the second a Combustion Engineering reactor ("Unit 2"). Specifically, this remand trial focused on four particular areas of expense which System Fuels contends were incurred to mitigate the government's partial breach: Boraflex degradation mitigation, use of dry storage casks, replacement of the L-3 loading crane, and replacement of the water transfer system. The evidence presented at the remand trial addressed causation and certain "avoided costs" associated with these four areas.

1. *Boraflex.*

Each unit at ANO is designed to operate with 177 nuclear assemblies in its core. 2012 Tr. 175:8-11 (Test. of Christopher Walker, Senior Engineer, ANO). These units must be periodically refueled, which involves offloading spent fuel into a spent fuel pool and bringing in fresh fuel to the reactors to replace spent fuel that is not reloaded.[7] At ANO, such refueling outages occur at 18-month intervals, and typically each refueling results in the replacement of one-third to one-half of the core, with the remaining fuel being placed back into the core along with fresh assemblies. 2012 Tr. 189:1-23 (Walker). Each unit at ANO has a separate spent fuel pool. The assemblies used in the two units have different physical configurations, and the racks used for assemblies in the two pools are not interchangeable.

In preparation for refueling and any type of unforeseen core offloads, ANO has historically strived to maintain full-core offload capability in its spent fuel pools (also known as "full core reserve"). Consequently, at any given time, ANO prefers to have at least 177 free cells in each pool, *i.e.*, enough open spaces in the pool for assemblies to allow the unit's entire core to be emptied into the pool if needed. Maintaining full core reserve is not required by the Nuclear Regulatory Commission ("NRC"), but it is considered desirable by ANO. 2012 Tr. 188:8-16, 195:10-196:3 (Walker). The pools each currently have a licensed pool capacity of 968 assemblies, but 46 cells are lost in each pool due to restrictions (for example, cooling piping interference or heavy loads). Of the remaining 922 open cells in each spent fuel pool, 177 would ideally be left open to maintain full core reserve. This creates what is called an "effective

[6]References to the transcript of evidence at the remand trial will be to "2012 Tr. __," and to the transcript of the original trial as "2007 Tr. __."

[7]Although refueling typically occurs by offloading all assemblies from the core at once (and then reinserting some assemblies along with fresh assemblies), ANO is also capable of doing an "in-core shuffle," in which only some of the assemblies are offloaded from the core while others are shuffled inside the core during refueling. *See, e.g.*, 2012 Tr. 829:25 to 830:20 (Test. of Dr. Jamie McCoy, Director of Engineering, ANO). ANO has performed in-core shuffles rather than full core offloads on several occasions in the past. *Id.*

capacity" or "one full-core reserve capacity" of 745 cells. *See* 2012 Tr. 68:9 to 69:5 (Metcalfe). These cells are available to store SNF and HLW, or to be left open as "water holes" to manage radioactivity in the pool by separating the "hottest" or freshest fuel assemblies from one another. The necessity of using certain geometrical arrangements, including water holes, is determined by a criticality analysis, which is a calculation designed to determine whether a spent fuel pool is operating with a sufficiently low "K-effective." 2012 Tr. 172:1-9 (Walker) ("[T]hose calculations account for pretty much all . . . conditions within the pool to the best of our ability, and we estimate the proper storage of those assemblies to meet the NRC basic requirements associated with the K-effective.").[8]

Once fuel has been removed from the core, it is stored on-site in the spent fuel pool while it cools. To cool its assemblies more quickly and to allow for more efficient loading patterns, ANO pursued a neutron poisoning strategy in 1983 by installing Boraflex, a silicon-based rubbery material impregnated with boron carbide, in both pools. 2012 Tr. 319:20 to 320:3 (Walker); 834:8-11 (McCoy). Neutron poisons absorb more neutrons than they emit, thereby reducing the K-effective. 2012 Tr. 177:19-25 (Walker). For a time, Boraflex appeared to be performing its intended function by absorbing neutrons from the assemblies, but within a few years, the nuclear industry began to perceive a problem with degradation of Boraflex when the material was exposed to radiation over certain levels. 2012 Tr. 834:12-22 (McCoy); DX 272 (Boraflex Degradation Report). Additionally, as it degrades, Boraflex releases silica into the spent fuel pools, and the silica must be removed prior to any refueling outage to avoid contaminating rods of assemblies in the reactor core. 2012 Tr. 290:2-18 (Walker); 1463:2 to 1464:23 (Test. of Gregory Maret, an expert witness testifying on behalf of the government).[9] In 2002, ANO began using reverse osmosis to remove silica from the pools of both units prior to refueling. 2012 Tr. 292:17 to 293:10 (Walker).

Because of the problems associated with Boraflex degradation, ANO ultimately stopped taking credit for Boraflex in its criticality calculations. Unit 1 credited Boraflex at various percentages of degradation until 2007, while Unit 2 ceased crediting Boraflex completely in 2003. 2012 Tr. 835:1-12 (McCoy). In 2001, the NRC "required ANO to develop a *long term solution* to prevent the Unit 1 and Unit 2 Technical Specifications and the criticality analysis for the Unit 1 and Unit 2 spent fuel pools from being violated due to the degradation of the

[8]The "K-effective" is a measure of neutron generation within the racks of the spent fuel pool. If the K-effective goes above 1, more neutrons are being generated than dissipated, which can result in a "runaway reaction" inside the pool. Keeping the K-effective below 1 results in a steady decrease in neutron generation and the cessation of disintegration reactions to a level approaching half-life background levels. 2012 Tr. 199:15 to 200:17 (Walker). ANO is required by its NRC licenses to maintain a K-effective below 0.95. 2012 Tr. 200:23 to 201:2 (Walker).

[9]As the silica matrix of the Boraflex panel disintegrates, the poison material and the silica leach out of the panel and into the water in the pool. *See* DX 272 at 1 (Boraflex Degradation Report). Once the silica concentration becomes too high, if the water from the pool were to mix with the water in the reactor coolant system, as happens during refueling, deposition of silica could occur on the cladding surface of assemblies in the reactor, impeding the transfer of heat and threatening the fission product barrier. 2012 Tr. 1464:1-25 (Maret).

[B]oraflex panels." PX 28-B-6 at 4 (Wet Storage System Upgrade Project Plan) (emphasis added). This requirement demanded that a long-term solution be developed by 2002, and was not dependent upon whether or not DOE performed on the Standard Contract. *Id.*; 2012 Tr. 373:9-18 (Walker). Plaintiffs have not alleged that any of the degrading characteristics of the Boraflex panels were caused by the government's breach. Rather, plaintiffs argue that, had DOE performed, ANO could have managed the defective Boraflex inserts with more efficiency and efficacy.

In the early 2000s, System Fuels pursued the development of a wholly new neutron poison, Metamic. DX 173 (Report to NRC on Metamic Research). In theory, Metamic could replace Boraflex as the primary neutron poison and mitigate the disappointing Boraflex performance in both units. ANO, however, experienced significant setbacks and delays on the Metamic project. Although ANO had requested license amendments anticipating a switch from Boraflex to Metamic as early as 2003, *id*. at 1, the product itself was still not ready for implementation prior to the cut-off date for damages in this action, June 30, 2006, *see, e.g.*, DX 531 (Unit 1 License Amendment Approval, Jan. 26, 2007); DX 532 (Unit 2 Approval for Change to Technical Specifications, Sept. 28, 2007).

Even after the Metamic panels were ready for insertion, they proved to be viable only for Unit 1. During research and development, ANO engineers slowly took account of a need to accommodate a difference in size between the Unit 1 and Unit 2 flux traps. Although the newly designed Metamic panels fit into Unit 1's flux traps, they were too large for those in Unit 2, and could not be altered to fit. 2012 Tr. 175:15-24 (Walker). Unit 1 received Metamic poison panels in 2007, at which time System Fuels stopped crediting Boraflex in its criticality analysis for that Unit, even though it left the existing Boraflex in Unit 1's spent fuel pool. *See* 2012 Tr. 835:1-20 (McCoy); DX 531 (Unit 1 License Amendment Approval, Jan. 26, 2007). To compensate for the loss of Boraflex and the inability to use Metamic in Unit 2, ANO implemented interim criticality analyses which did not credit Boraflex in Unit 2 in 2003. DX 517 (Unit 2 License Amendment Request, June 30, 2003); DX 518 (Unit 2 License Amendment Approval, Sept. 3, 2003). In 2007, ANO performed a partial re-rack of Unit 2, which removed all (then-uncredited) Boraflex from that pool. *See* 2012 Tr. 178:19-23 (Walker).

In a change of position, the government challenges damages for both the Unit 2 partial re-rack and for the development and insertion of Metamic in Unit 1. Damages for replacement of Boraflex were conceded by the government and awarded to plaintiffs in the 2007 trial. *See System Fuels III*, 79 Fed. Cl. at 63 (Although "[t]he government . . . contend[ed] that the extent and timing of Boraflex degradation would have been the same in both the actual and non-breach worlds[,] . . . [it] concedes that under [the 3000 rate] there should be no offset [reducing Plaintiff's costs for Boraflex replacement].") The government retracts that concession and now argues that plaintiffs have failed to demonstrate a causal connection between DOE's non-performance and the Boraflex issues which ultimately led to the Metamic project and the re-rack and, and that no damages should be awarded for either the Metamic poison panel inserts or the re-rack. Def.'s Post-Trial Br. at 8-23. Plaintiffs claim $3,139,084 for the Metamic Panel Project and $966,758 for the Unit 2 partial re-rack, for a total of $4,105,842 in damages relating to Boraflex degradation. *See* DRDX 4 at 18.

2. *Dry storage casks.*

When the spent fuel pools begin to fill, fuel that has cooled a number of years can be removed from the pool and loaded into dry storage casks. The number of assemblies per cask, as well as the minimum cooling period prior to being loaded into the cask, varies depending upon the unit involved and the cask being used. Plaintiffs first contemplated a need for dry storage in the early 1990s, when they opted to construct an independent spent fuel storage installation ("ISFSI") rather than to pursue a re-rack at ANO Unit 1. PX 500 at 4 (Metcalfe Report); DX 266 at 1 (ANO VSC History.[10] Initially, ANO used a VSC-24 cask, which could hold up to 24 assemblies per cask, and required roughly ten years of cooling time before SNF could be loaded into those casks. 2012 Tr. 82:22 to 83:2 (Metcalfe); 219:2-9 (Walker). ANO's ISFSI was completed and loaded its first VSC-24 casks on December 17, 1996, and April 2, 1997, for Units 1 and 2, respectively. DX 266 at 4-5 (ANO VSC History).

After having loaded twenty-four VSC-24 casks, ANO switched to a Holtec cask system. The Holtec system uses HI-STORM casks. 2012 Tr. 180:5-18 (Walker); PX 87 at 29 (2003 Spent Fuel Management Plan). The HI-STORM cask selected for use at ANO ("Holtec cask") can store 24 or 32 assemblies, depending upon the unit involved, and it can accept fuel that has cooled for seven to eight years. 2012 Tr. 180:10-19, 220:1-5 (Walker); *see also* 2007 Tr. 596:1-6 (Franklin). ANO incurred costs for 28 Holtec casks through the end of the claim period, although only 22 casks were actually loaded prior to June 30, 2006. *System Fuels III*, 79 Fed. Cl. at 50, 58 n.22.

Both System Fuels and the government have agreed that in any non-breach scenario, a minimum of fifteen VSC-24 casks would have been loaded into dry storage at ANO. *See* Def.'s Post-Trial Br. at 26; Pls.' Post-Trial Br. at 6; *see also System Fuels III*, 79 Fed. Cl. at 55. Furthermore, the court held in 2007 that the necessity of purchasing and loading Holtec casks was the result of the government's breach, and that holding is not at issue on remand. *System Fuels III*, 79 Fed. Cl. at 58. The parties diverge now only over the last nine of the twenty four VSC-24 casks. The government argues on remand that under the 1987 rate, ANO would have loaded all twenty-four VSC-24 casks that it loaded in the real-world breach scenario, and that it should not be liable for the cost of the additional nine casks. Def.'s Post-Trial Br. at 26. Plaintiffs contend that the shift from the 3000 rate to the 1987 rate would effect no change in ANO's dry storage needs in the non-breach world, and that the original award of damages for the nine additional casks should remain intact. Pls.' Post-Trial Br. at 11; PX 500 at 5 (Metcalfe Report). Plaintiffs claim a total of $9,110,424 for acquisition, loading, and placement of the nine contested VSC-24 casks. *See* DX 538 at 6, 9 (Peterson Report).

3. *Water transfer system.*

To transfer assemblies from the spent fuel pools into dry storage casks, ANO has to use a water transfer system in concert with a work platform. Work platforms are structures used to stage the movement of assemblies. First, working at the cask loading pit associated with the

[10]For a detailed description of the process of loading and storing dry storage casks, see *System Fuels III*, 79 Fed. Cl. at 49, 53-54.

spent fuel pool, assemblies are placed in a multi-purpose canister inserted into a transfer cask. That cask is then lifted from the cask loading pit to the work platform, where workers can prepare the canister for movement from the transfer cask to the HI-STORM steel and concrete storage module. *See System Fuels III*, 79 Fed. Cl. at 50 (providing a detailed description of the steps involved). The water transfer system is used to raise or lower the water levels in the cask pit during various stages of loading the canister inside the transfer cask and readying the transfer cask and canister for movement. *See id.*; *see also* 2012 Tr. 1054:21 to 1055:10 (Test. of Darrell Williams, former Entergy Senior Project Manager).

When ANO was using VSC-24 casks, both units availed themselves of a single movable temporary water transfer system, which could be assembled and disassembled with each use. 2012 Tr. 1055:11 to 1056:15 (Williams). This temporary water transfer system had been designed to be compatible with the VSC-24 cask work platform; it could not be used with the Holtec work platform because the Holtec platform was too large. *See* 2012 Tr. 1057:16 to 1058:20 (Williams). Although the water transfer system was originally intended to be temporary, as the name implies, it was used by ANO from 1996 until 2003 when ANO made the change from VSC-24 to Holtec dry storage casks. 2012 Tr. 1082:9-15 (Williams); 1344:24 to 1345:9 (Test. of Warren Brewer, an expert witness testifying on behalf of the government). To accommodate the Holtec work platform, ANO installed new, permanent water transfer systems at each Unit. 2012 Tr. 1056:20 to 1057:20 (Williams).

The parties do not dispute the necessity of using the Holtec work platform with Holtec casks, 2012 Tr. 1326:2-10 (Brewer), but they diverge on whether ANO would have replaced the temporary water transfer system absent the government's breach, Pls.' Post-Trial Br. at 28; Def.'s Post-Trial Br. at 34. Plaintiffs claim $1,415,847 in damages for the cost of replacing the temporary water transfer system, while the government contends that ANO cannot demonstrate sufficient causal connection to the government's breach, and that plaintiffs would have replaced the water transfer system in any event. Pls.' Post-Trial Br. at 28; Def.'s Post-Trial Br. at 34-35.

4. *L-3 Crane.*

The process of loading assemblies is accomplished by using cranes to lift and move the various heavy pieces of equipment involved. 2012 Tr. 630:1 to 631:13 (Supko). At issue is the L-3 crane, which was used to shift loaded transfer casks, among other things. The L-3 crane was upgraded during the shift to Holtec casks, and the cause of that upgrade is disputed.

A significant issue with the switch from VSC-24 casks to Holtec casks was the weight differential between the two models. Both units at ANO used the L-3 crane to accomplish the movement of loaded transfer casks. 2012 Tr. 614:2-7 (Supko). The original L-3 crane, used for loading VSC-24 casks, was capable of lifting up to 100 tons and was not single failure proof. 2012 Tr. 604:2-8 (Supko); 1043:22-24 (Williams).[11] This crane was adequate for loading VSC-

[11]"Single failure proof" refers to the characteristic of a crane making it capable of experiencing failure of a single component without dropping its load. 2012 Tr. 597:20-23 (Supko). This is accomplished by creating redundancies in the design of the crane, such that essential components such as hooks, cables, motors, or brakes, have back-up components which

24 casks because they weighed at most only 100 tons fully loaded and were capable of withstanding a cask drop. In contrast, Holtec casks were heavier (varying between 119 to 125 tons, depending on the amount of water in the cask), 2012 Tr. 1048:17-22 (Williams), and also measurably thinner than the VSC-24, 2012 Tr. 1044:21 to 1045:4 (Williams).

Because the Holtec casks were both heavier and less drop-resistant than the VSC-24s, ANO could not use the 100-ton, non-single failure proof L-3 crane to load them. *See* 2012 Tr. 617:7-16 (Supko) ("The L-3 crane as it stood [prior to the upgrade] couldn't have lifted something that weighed more than 100 tons."). NRC requirements mandate that either a crane must be single failure proof, or the utility must perform cask-drop analysis to demonstrate that the cask is capable of withstanding a drop commensurate to that which it may experience in case of crane failure. *See* 2012 Tr. 1357:18-25 (Brewer). After performing drop evaluations for the Holtec cask, ANO learned that even using various impact limiters, the cask could not pass a drop test. 2012 Tr. 451:4-15 (Walker). ANO accordingly upgraded the crane to single failure proof at the same time that it increased the lifting capacity. 2012 Tr. 1147:2-8 (Williams). To compensate for the differences between VSC-24 casks and Holtec casks, ANO upgraded the L-3 crane in 2003 to a 130-ton, single failure proof configuration. *See* PX 515 at 7 (2003 NRC License Amendment).

Plaintiffs claim that the upgrades to the L-3 crane are recoverable as damages because the upgrades were necessitated by DOE's failure to perform any pickups of its SNF, arguing that, had DOE relieved it of SNF, it could have avoided any use of Holtec casks. Pls.' Post-Trial Br. at 12. Accordingly, they claim $3,291,974 for the cost of the L-3 crane upgrade. *See* DX 538 at 9 (Peterson Report). The government contends that ANO would have upgraded the crane to single failure proof capability regardless of DOE performance, and furthermore, that ANO could have selected a Holtec cask light enough to be lifted by a 100-ton crane. Def.'s Post-Trial Br. at 40-41. The government also objects to certain costs associated with the crane upgrade, such as remote control operation capability, a motorized crane hook, and an increase to the crane's auxiliary hook capacity, each of which the government claims were standard crane upgrades at the time, and thus cannot be causally linked to DOE's partial breach. *Id.*

PROCEDURAL HISTORY

System Fuels filed suit in this court on November 5, 2003, alleging partial breach of contract, breach of the implied covenant of good faith and fair dealing, and an uncompensated taking. On April 20, 2005, this court granted summary judgment to the plaintiffs on liability for the partial-breach-of-contract claim. *System Fuels I*, 65 Fed. Cl. at 175-76. The court limited the scope of damages to be addressed at trial to those damages incurred prior to the close of System Fuels' most recent fiscal year directly preceding trial. *Id.* at 177 (adopting the exceptions to the rule of merger and bar in accord with *Restatement (Second) of Judgments* § 26(1)(b) and (e) (1982), thus contemplating that plaintiffs would bring additional suits later for damages incurred

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ensure continuous function even if a primary component were to fail. 2012 Tr. 1044:10-17 (Williams). Conversely, a non-single failure proof crane would drop its load if one of the essential components failed, necessitating the use of a cask capable of withstanding such a drop, like the VSC-24.

in subsequent fiscal years). System Fuels moved to amend and supplement the complaint so as to request damages incurred through June 30, 2006, and the court granted this enlargement of the damages cut-off date. *System Fuels II*, 73 Fed. Cl. at 213-14. At trial, the parties agreed that DOE should have begun collection of SNF and HLW from ANO in 2001, but differed as to what acceptance rate was proper for calculating damages. *System Fuels III*, 79 Fed. Cl. at 55. On October 16, 2007, the court issued a post-trial opinion holding that plaintiffs were entitled to recover a total of $48,651,728, using the rate proffered by plaintiffs (the 3000 MTU rate) to calculate the quantum. *Id*. at 54, 64-68, 74. The court rejected plaintiffs' claims for project financing costs, administrative and engineering overhead costs, and a portion of the salary and non-salary labor costs. *Id.* The government's request that the damages be offset by the "economic benefit" obtained by System Fuels in deferring full payment of the one-time fee was also denied. *Id.* at 74.

The government appealed the court's award of damages, and plaintiffs cross-appealed the denial of cost-of-capital and capital-suspense-loader damages. *See System Fuels V*, 457 Fed. Appx. at 933. On appeal, the Federal Circuit affirmed the trial court's denial of an offset in damages associated with System Fuels' deferral of the one-time fee, as well as the denial of System Fuels' claim for financing costs. The trial court's denial of System Fuels' capital-suspense-loader costs was reversed. *Id*. at 935-936.[12]

In the interim between the post-trial decision and judgment and the resulting appeals, the Federal Circuit had issued two significant opinions touching upon causation in NWPA partial-breach cases: *Pacific Gas and Elec. Co. v. United States*, 536 F.3d 1282 (Fed. Cir. 2008), and *Yankee Atomic Elec. Co. v. United States*, 536 F.3d 1268 (Fed. Cir. 2008). Adhering to the holdings of those two cases, the Federal Circuit found that the court had erred by adopting the 3000 rate in its causation analysis. Instead, the court should have followed the 1987 rate as held in *Pacific Gas*. 536 F.3d at 1292 (holding that the 1987 rate "provide[d] the best available pre-breach snapshot of both parties' intentions for an acceptance rate" and "contemplated full and timely performance" by the government). In *Yankee Atomic*, the Federal Circuit held that plaintiffs have the "burden to prove the contractual acceptance rate and apply that rate before suggesting that the [g]overnment's breach was a substantial factor in causing [their] claimed expenses." 536 F.3d at 1273. In keeping with those holdings, the Federal Circuit remanded the issue of causation in the present case to the court, stating that "on remand, the trial court must hold [System Fuels] to this burden" of demonstrating causation between the government's non-performance under the 1987 rate and plaintiffs' claimed damages. *System Fuels V*, 457 Fed. Appx. at 934.

The remand trial was conducted over seven days and was completed on November 30, 2012. Closing arguments were held on March 18, 2013.

[12]Although the trial court's decision on suspense-loader costs was reversed, quantification of damages related to the suspense loader was not remanded, and such quantification is not dependent upon the choice between the 3000 rate and the 1987 rate. As such, the $3,323,930 claimed by plaintiffs as suspense-loader costs was not disputed in this remand trial. *See System Fuels III*, 79 Fed. Cl. at 63; *System Fuels V*, 457 Fed. Appx. at 935-36.

STANDARD FOR DECISION

Under the mandate rule, "the nature of the district court's remaining tasks is discerned not simply from the language of the judgment, but from the judgment in combination with the accompanying opinion." *Exxon Chem. Patents, Inc. v. Lubrizol Corp.*, 137 F.3d 1475, 1483 (Fed. Cir. 1998) (citing *In re Sanford Fork & Tool Co.*, 160 U.S. 247, 256 (1895), and *Laitram Corp. v. NEC Corp.*, 115 F.3d 947, 952 (Fed. Cir. 1997)); *see Laitram*, 115 F.3d at 951 ("[T]he district court's actions on remand should not be inconsistent with either the letter or the spirit of the mandate."). Therefore, the court must look to the Federal Circuit mandate and opinion for guidance in addressing the remand. Interpretation of the appellate mandate is a question of law. *Laitram*, 115 F.3d at 950-51.

Apart from remanding for application of the 1987 rate in a causation analysis, the Federal Circuit "place[d] no limitations . . . on [the] remand order" regarding the "determin[ation of] facts and award of damages supported by those facts." *System Fuels V*, 457 Fed. Appx. at 934.

Damages for a breach of contract case should be "sufficient to place the injured party in as good a position as it would have been had the breaching party fully performed." *Indiana Mich. Power Co. v. United States*, 422 F.3d 1369, 1373 (Fed. Cir. 2005). Such damages must be (1) reasonably foreseeable by the breaching party at the time of contracting; (2) caused substantially by the breach; and (3) shown with reasonable certainty. *Energy Capital Corp. v. United States*, 302 F.3d 1314, 1320 (Fed. Cir. 2002); *see also Indiana Mich. Power Co.*, 422 F.3d at 1373; *Pacific Gas*, 92 Fed. Cl. at 179. Although damages "need not be calculable with mathematical accuracy," *Restatement (Second) of Contracts* § 352 cmt. a (1981), "recovery for speculative damages is precluded," *Indiana Mich. Power Co.*, 422 F.3d at 1373 (citing *San Carlos Irr. & Drainage Dist. v. United States*, 111 F.3d 1557, 1563 (Fed. Cir. 1997)). In the present case on remand, the government has challenged neither the reasonable foreseeability nor the reasonable certainty of plaintiffs' damages. In the circumstances, the court here addresses only the question of substantial causation. Plaintiffs must establish "to a reasonable certainty" that the alleged damages were caused by the government's breach of the Standard Contract by applying the 1987 rate. *See Pacific Gas*, 92 Fed. Cl. at 179. Plaintiffs must show that the claimed costs incurred in the actual world would not have been incurred in the "but[-]for world," had DOE performed as per the Standard Contract. *See Energy Nw. v. United States*, 641 F.3d 1300, 1306 (Fed. Cir. 2011).

If plaintiffs can establish causation to a reasonable certainty, "the burden shifts to defendant to prove that such damages could have been avoided by reasonable efforts." *Pacific Gas*, 92 Fed. Cl. at 179 (internal citations omitted) (citing *Indiana Mich. Power Co.*, 422 F.3d at 1375); *see also Restatement (Second) of Contracts* § 350, cmt. b ("As a general rule, a party cannot recover damages for loss that he could have avoided by reasonable efforts."). The government must demonstrate that plaintiffs "did not undertake reasonable efforts to mitigate [their] damages or that the efforts [they] did undertake were insufficient or unreasonable." *Tennessee Valley Auth. v. United States*, 69 Fed. Cl. 515, 523 (2006).

ANALYSIS

Respecting the four areas of contention on remand, System Fuels argues that the shift from the 3000 rate to the 1987 rate does not diminish the damages previously awarded by the court. Pls.' Post-Trial Br. at 3. As such, they claim the same damages as those awarded in the original trial, $48,651,728, plus the capital suspense loader of $3,323,930 allowed by the Federal Circuit on appeal, for a total judgment of $51,975,658. *See id*. The government frames its objections in terms of causation, but it primarily relies on factors and circumstances unrelated to a change in the pickup rate.

A. *Boraflex Degradation*

The government resists plaintiffs' claim for damages due to Boraflex degradation on the ground that System Fuels' costs to remove and replace Boraflex were not causally linked to DOE's non-performance on the Standard Contract. Def.'s Post-Trial Br. at 8. Plaintiffs counter that this challenge is inappropriate because the government failed to contest Boraflex mitigation under the 3000 rate at the original trial. Pls.' Post-Trial Br. at 32.

1. *The government's original concession of Boraflex damages.*

During the 2007 trial, "the government concede[d] that under [the 3000 rate] there should be no offset" of System Fuels' claimed damages related to Boraflex degradation but rather that all of System Fuels' Boraflex-related damages should be allowed. *System Fuels III*, 79 Fed. Cl. at 63. Given this concession and the court's finding that the 3000 rate applied, the court did not perform any detailed analysis of the causation of Boraflex degradation costs based upon the record of the first trial. Plaintiffs now argue that this concession estops the government from pressing its present objections to the Boraflex costs. Pls.' Post-Trial Br. at 32 (citing *New Hampshire v. Maine*, 532 U.S. 742, 749 (2001) ("[W]here a party assumes a certain position in a legal proceeding, and succeeds in maintaining that position, he may not thereafter, simply because his interests have changed, assume a contrary position, especially if it be to the prejudice of the party who has acquiesced in the position formerly taken by him.")). Plaintiffs consequently contend that "the only question in this remand is whether the difference between the 1987 [rate] and the [3000] rate would have [affected System Fuels'] need to implement the Boraflex mitigation projects." *Id.* The plaintiffs premise much of their argument on a comparison between the 3000 rate and the 1987 rate, positing that because the rates are so similar, "there is *no* possible justification for a change in the result." *Id*.

The Federal Circuit's remand in this case encompasses "causation analysis in view of *Pacific Gas*[] and *Yankee Atomic*[]," specifically placing "no limitations" on the remand order with regard to the scope of factual development and analysis of causation. *System Fuels V*, 457 Fed. Appx. at 934, 936. The Federal Circuit did not constrain the analysis to the difference between the 3000 rate and the 1987 rate. The salient question at hand is whether the court of appeals' no-limitations addendum to its rate-related causation remand allows the government to withdraw its prior concession and now hold plaintiffs to their burden of proof and persuasion regarding causation for damages associated with Boraflex replacement. The court concludes that the court of appeals' remand order has that effect. The causation analysis intentionally was

reopened fully by the court of appeals, except in the three areas specifically addressed in the Federal Circuit's opinion, *i.e.*, its affirmance of the denial of any benefit to the government attributable to plaintiff's deferral of the one-time fee, its affirmance of the denial of plaintiffs' cost of capital for the costs incurred in its mitigation efforts, and its reversal of the denial of capital-suspense-loader expenses. Consequently, the government may withdraw its prior concession. *See Yankee Atomic Elec. Co. v. United States*, 679 F.3d 1354, 1360-62 (Fed. Cir. 2012) (affirming a trial court's decision to allow plaintiffs to retract a concession limiting damages, affirming the trial court's decision to foreclose the government from urging a position on remand that it had not taken at the original trial, and reversing the trial court's decision that plaintiffs could not reopen a claim for wet storage pool costs). In *Yankee Atomic*, the Federal Circuit's decision regarding reopening the record on remand to allow new evidence on wet storage pool costs is particularly instructive. The trial court had construed a remand order as calling only for reexamination of "causation for 'discrete costs previously avoided.'" *Id*. at 1362. The court of appeals ruled that this interpretation was "too narrow." *Id*. Instead, "[t]he remand was ordered '[b]ecause the [trial court] did not assess damages according to the rate at which the [g]overnment was contractually obligated to accept the utilities' waste.'" *Id*. (quoting *Yankee Atomic*, 536 F.3d at 1271). So too here. The no-limitations remand allows the government to address causation by reaching more broadly than the positions it took at the first trial. *See Pacific Gas & Elec. Co. v. United States*, 668 F.3d 1346, 1351-52 (Fed. Cir. 2012) (ruling that the court of appeals' mandate did not bar the trial court from reconsidering a utility's claims for private fuel storage). Plaintiffs accordingly bear the burden of demonstrating a causal link between the government's breach under the 1987 rate and the damages claimed to be associated with Boraflex.

2. *Causation analysis.*

At trial, plaintiffs attempted to demonstrate causation between DOE's non-performance on the Standard Contract under the 1987 rate and the necessity of mitigating Boraflex degradation at ANO. Specifically, System Fuels contends that because of DOE's breach, ANO was forced to develop and install Metamic panels in Unit 1 and undertake a partial re-rack in Unit 2. Pls.' Post-Trial Br. at 15. Had DOE performed, plaintiffs argue, ANO could have avoided both the Metamic project and the partial re-rack "by implementing or enhancing . . . criticality controls[], including performing the Boraflex mitigation actions earlier in time and moving hotter fuel into non-Boraflex regions of the pools." *Id.* While plaintiffs have sufficiently demonstrated that the Metamic project and the partial re-rack are causally related to the failure of Boraflex as a product, the key question is whether those mitigating measures are also linked to the failure of DOE to perform on the Standard Contract.

Degradation of Boraflex occurs when gamma radiation and water in the spent fuel pools interact with the polymer matrix of the material. DX 272 at 1 (Boraflex Degradation Report); 2012 Tr. 1500:16-18 (Maret) ("The polymer is broken down through the impact of the gamma radiation on a polymeric chemical structure."). With the degradation, the Boraflex has a reduced capacity to absorb neutrons from the pool system. 2012 Tr. 1500:15-23 (Maret). The degradation of the Boraflex material also initiates the release of silica, contaminating the pool. 2012 Tr. 290:2-18 (Walker); 1463:2 to 1464:23 (Maret). To remove the silica contamination from the spent fuel pools, ANO had to perform treatment of the water in the spent fuel pools

prior to refueling, which treatment disturbed the chemical equilibrium of the pool with each performance. 2012 Tr. 986:12-20 (McCoy). Such disturbance in chemical equilibrium further exacerbates degradation of the Boraflex. 2012 Tr. 986:21-25 (McCoy).[13]

ANO installed Boraflex in 1983, before the issues with degradation were known to the industry. *See System Fuels III*, 79 Fed. Cl. at 62. In 1996, thirteen years after Boraflex was installed, engineers at ANO noted that "[t]he bulk of the ANO spent fuel storage cells have achieved [the] dose [above which dissolution is no longer insignificant]." PX 300 at 4 (Response to Generic Letter 96-04, "Boraflex Degradation in Spent Fuel Pool Storage Racks"). Indeed, at the first trial, there was testimony that System Fuels had begun observing degradation at ANO as early as 1987. *See* 2007 Tr. 1337:23 to 1338:4 (McCoy).

Under the 1987 rate, ANO's first acceptance rights would have occurred in 1999, sixteen years after Boraflex was installed at ANO, twelve years after degradation was first observed, and at least three years after the radiation dosage on the racks had passed the threshold to become significant. *See* PX 501 at 2 (Supko Supplemental Report) (showing that under the 1987 rate ANO had no acceptance rights in 1998, and acceptance rights for Unit 1 beginning in 1999, totaling 50 assemblies, or 23.22 MTU). By 2001, System Fuels found that the Boraflex degradation was "steadily increasing at an alarming rate," noting at that time that some Boraflex panels had degraded in excess of 35%, and a few isolated panels had even experienced complete panel loss. PX 28-B-6 at 4 (Wet Storage System Upgrade Project Plan). System Fuels had to cope with the degraded Boraflex until 2007, well after the claim period had already ended, when it was able fully to implement the mitigatory measures for which it now seeks damages. *See* 2012 Tr. 835:1-8 (McCoy) (noting completion of the Metamic panel insert project on Unit 1 in 2007); DX 532 (Unit 2 Approval for Change to Technical Specifications, Sept. 28, 2007).[14] System Fuels nonetheless contends that DOE performance beginning in 1999 could have obviated the need for the mitigation costs.

System Fuels avers that it could have avoided extensive damage to Boraflex with DOE performance by "[l]oading [h]otter [f]uel [t]o [t]he [g]overnment." Pls.' Post-Trial Br. at 16; *see also* 2012 Tr. 836:17 to 837:4 (McCoy). Under the Standard Contract, DOE agreed to accept assemblies which had cooled a minimum of five years prior to pick-up. DX 1, Art. VI.A.1(a) and App. E.B.3 (Pls.' Standard Contract). The level of gamma radiation emitted by spent fuel is

[13]Plaintiffs suggested that in a but-for world of DOE performance, ANO could have established an equilibrium of silica in the spent fuel pool so as to eliminate degradation due to silica release. 2012 Tr. 269:12 to 270:19 (Walker). Stabilizing the silica levels could have decreased the rate of Boraflex degradation, but it would have been impractical. During refueling cycles, ANO had to move assemblies into and out of the spent fuel pools. Silica had to be removed from the pool to allow assemblies to be shifted from and into the reactor, and equilibrium would necessarily be lost, rendering this method of preserving Boraflex essentially impossible to achieve. 2012 Tr. 1486:5 to 1487:15 (Maret).

[14]System Fuels seeks as damages its costs during the claim period, *i.e.*, through June 30, 2006, in developing the Metamic panels and the other preparatory steps to undertake the mitigation actually implemented in 2007.

"at [its] highest when it's immediately discharged," and "more than 90 percent of the gamma dose happens and therefore the impact on the [Boraflex] polymeric material happens in the first year and th[en] tails off because it's an exponential decay." 2012 Tr. 1500:2 to 1501:12 (Maret); *see also* 2012 Tr. 985:8-16 (McCoy); Pls.' Post-Trial Br. at 16 ("[T]he radiation levels from the spent fuel assemblies would have declined significantly during the five-year cooling period required by the Standard Contract."). The damage rate to Boraflex would be "dramatically higher on the front end in those first several days than it is a week later or a month later or two months later." 2012 Tr. 1528:12-16 (Maret). Because of the exponentially rapid rate of decay after removal of SNF from the reactor, the diminution in Boraflex degradation effected by transferring hotter SNF, *i.e.*, that which is slightly more than five years old, to DOE would not be too significant. The peak levels of gamma radiation from recently discharged SNF would have already occurred. Furthermore, the silica washout associated with Boraflex degradation is not necessarily lessened by exposure to cooler fuel. 2012 Tr. 1528:19-22 (Maret); 1009:1-16 (McCoy). In sum, even had DOE been performing its SNF pickup obligations under the Standard Contract, ANO would still have had to cope with the Boraflex degradation at roughly the same level it experienced in the actual world.

Plaintiffs also posited that in the but-for world with DOE performance, it would have removed all assemblies from the Boraflex regions of the pools and used those open spaces only during refueling. 2012 Tr. 454:18 to 455:2 (Walker); 1003:15 to 1006:5 (McCoy). This would have limited the exposure of Boraflex to SNF and mitigated its degradation to some extent. The viability of such a plan would turn upon whether there were enough spaces for assemblies in the spent fuel pool that ANO could have afforded to leave the Boraflex region empty for most of the refueling cycles. 2012 Tr. 217:25 to 218:8, 455:3-5 (Walker). The effort of keeping the Boraflex region empty would constrain ANO's ability to implement favorable loading patterns in the remaining regions, *see* 2012 Tr. 1581:3-11 (Test. of Jonathan Neuberger, an expert testifying on behalf of the government), which would adversely affect ANO's criticality analysis by limiting the effectiveness of using geometric loading patterns to reduce the K-effective.

ANO never modeled the effect of removing fuel from the Boraflex region, placing this contention into the realm of speculation. 2012 Tr. 403:8-22, 453:13 to 455:11 (Walker). Plaintiffs sought to excuse this lack of analysis by pointing to the fact that the government never provided a certificate of compliance for a transport cask which would have been brought by DOE to load fuel from ANO, had it performed. Pls.' Post-Trial Br. at 33.[15] Plaintiffs' witnesses conceded that they could have modeled a Boraflex-zone-limiting scenario with the simple assumption that "DOE would just take the fuel that's most beneficial to [System Fuels] as long as it meets that five-year cooled parameter." 2012 Tr. 455:6-11 (Walker). Absent specific information, however, the court has no means of quantifying the percentage of actual Boraflex degradation which could have been forestalled. This contention by plaintiffs to support its Boraflex claim accordingly fails for lack of proof. *See Roseburg Lumber Co. v. Madigan*, 978 F.2d 660, 667 (Fed. Cir. 1992) ("Contract law has long been held to preclude recovery for speculative damages. Absent tangible proof of damages, appellant may not recover for an alleged injury." (internal citations omitted)); *Electronic & Missile Facilities, Inc. v. United*

[15]A certificate of compliance details the loading requirements of a particular cask and determines what type of assemblies may be loaded into the cask. 2012 Tr. 447:3-6 (Walker).

States, 189 Ct. Cl. 237, 257 (1969) (noting that damages may be awarded without "absolute exactness or mathematical precision," but only "where responsibility for damage is clear").

Finally, plaintiffs point to the fact that ANO was able to persevere with Boraflex degradation throughout the claim period, notwithstanding DOE's failure to perform. During the interim between when ANO identified a problem with Boraflex degradation and when it implemented the Metamic panel inserts and partial re-rack claimed here, ANO continued to manage the Boraflex in its spent fuel pools through various measures derived from its criticality analyses. Had DOE performed, plaintiffs argue, ANO "could have continued to operate with the interim criticality analys[e]s indefinitely." 2012 Tr. 1002:7-13 (McCoy).

According to testimony from Dr. McCoy, had plaintiffs known in the period from 1994 to1996 that DOE was going to perform, there were "at least [ten] different methods for a criticality[-] analysis control that [ANO] could have used, all of which would have helped [them] to maximize the lifetime of Boraflex." 2012 Tr. 836:13-20 (McCoy); *see also* 2012 Tr. 844:23 to 845:23 (McCoy) ("[W]e didn't have [DOE] performance. We were looking at the 1996 timeframe. . . . Ultimately[,] the decision was let's proceed with dry field storage and we'll do the best that we can to help Boraflex along, but we didn't have as comprehensive a strategy to prolong Boraflex.").[16] During this period, plaintiffs chose not to maximize Boraflex life, but rather to replace Boraflex. System Fuels avowedly adopted a strategy determined by the Boraflex project team to be "the lowest cost means to provide regulatory required criticality control for the storage of fuel," namely, replacement of Boraflex in criticality analysis through Metamic installation and partial re-rack. 2012 Tr. 380:5-12 (Walker).

The connection between plaintiffs' assertion that ANO could have maintained interim criticality analysis "indefinitely" and the proposition that Boraflex could have been maintained is tenuous at best. Managing criticality at ANO did not necessarily decrease Boraflex degradation; rather, it simply meant that *in spite* of Boraflex degradation, "there [wa]s still adequate margin to assure that the fuel in the spent fuel pool remain[ed] sub-critical." 2012 Tr. 1480:18 to 1481:7 (Maret). Of the "ten different methods" discussed at trial, ANO was using at least seven of them in the actual world prior to the close of the claim period. *See* 2012 Tr. 214:19-23, 225:17 to 226:5, 368:18 to 369:11 (Walker) (affirming that ANO credited cool-time, burn-up, geometry, boron insertion, control components, and leakage in the actual world during the claim period, in addition to using blocker plates).

Other methods suggested by plaintiffs to preserve Boraflex offer speculative hope at best, though certainly they would all have helped maintain criticality in the pools. Plaintiffs posit that

[16]While plaintiffs at times refer to the "ten methods" for criticality-analysis control, the government refers to eleven. *See, e.g.*, 2012 Tr. 1480:3-15 (Maret). This discrepancy may be explained by the fact that plaintiffs' witnesses treated the removal by DOE of 5-year cooled fuel separately, while the government witnesses treated that measure as part of this set of controls. The group of ten methods consists of: crediting geometry and fuel-placement patterns, soluble boron insertion, leakage, burn-up, cooling time/actinide decay, control components, recalibration of the RACKLIFE program, giving partial credit for Boraflex, using blocker plates, and increasing the equilibrium of silica in the spent fuel pools. 2012 Tr. 254:8 to 256:9 (Walker).

they could have recalibrated the RACKLIFE computer program to yield slightly less conservative results. 2012 Tr. 222:3-20 (Walker).[17] Mr. Maret testified that such a recalibration was unlikely to be approved by the NRC, however, because of the pervasive nature of the Boraflex-degradation phenomenon. 2012 Tr. 1519:11 to 1520:4 (Maret). Under plaintiffs' view, if RACKLIFE could yield lesser estimations of the Boraflex degradation at ANO, they could have then continued to take partial credit for Boraflex much longer than they did in the actual world. Pls.' Post-Trial Br. at 18 ("[I]n a world of DOE performance, ANO could have continued to credit Boraflex, even with degradation above [30% and 10%], which would have bought more time for the [g]overnment to perform while ANO continued to use its existing spent fuel pool racks."). This assertion is discordant with the fact that limitations on acceptable percentages of degradation were incorporated in the criticality analyses for both of ANO's Units, alteration of which would have required NRC approval. 2012 Tr. 872:23 to 874:2 (McCoy); 1467:22 to 1468:12, 1481:18 to 1484:9 (Maret); *see also* 2007 Tr. 1342:18 to 1343:5) (McCoy) (describing an attempt by System Fuels to credit beyond 10% degradation in Unit 1 which was ultimately rejected by NRC).

Taken as a whole, plaintiffs' "ten methods" do not demonstrate that ANO could have preserved Boraflex with DOE performance. The majority of these methods were in fact employed at ANO in the actual world to satisfy criticality constraints. The presence of Boraflex in the spent fuel pool racks at ANO posed an enduring problem for the plant. None of the criticality measures applied by ANO could have stopped Boraflex degradation at ANO. *See* 2012 Tr. 1522:12-20 (Maret). They would not have presented a "long-term solution" as required by the NRC in 2001. *See* PX 28-B-6 at 4 (Wet Storage System Upgrade Project Plan). They would only have prolonged the period during which ANO had to undertake interim measures until the inevitable removal or replacement of Boraflex took place. As a result, System Fuels has failed to link DOE's non-performance to its efforts to mitigate the Boraflex degradation at ANO.

B. *Dry Storage Casks*

At the original trial and the remand trial, the parties conceded that the first fifteen VSC-24 casks loaded onto the ISFSI would have been necessary whether DOE performed or not. *System Fuels III*, 79 Fed. Cl. at 55. The court determined after the first trial that under the 3000 rate, the government was liable for the loading of nine additional VSC-24 casks and 22 Holtec casks onto the expanded ISFSI. *Id.* at 58. Correlatively, the use of the Holtec casks was not contested at the remand trial. The government does challenge System Fuels' claim to damages for loading the last nine VSC-24 dry storage casks, arguing that ANO would have loaded those nine casks into dry storage even if DOE had performed at the 1987 rate. *See* Def.'s Post-Trial Br. at 26. Under the government's reading of the facts, the nine additional casks would have been necessary because of Boraflex degradation and the need to maintain full core reserve in the pools. *Id.* at 26-29.

System Fuels relies in part upon this court's analysis regarding application of the 3000 rate in the first trial, as a point of reference for its 1987-rate fuel management model. *See* Pls.'

[17]RACKLIFE is a computer program designed to perform computations such as measuring Boraflex degradation that play into criticality analyses. 2012 Tr. 221:10-15 (Walker).

Post-Trial Br. at 10-11. It also urges adoption of a model constructed by its expert witness, Mr. Metcalfe, which demonstrates that there would be no significant change in ANO's dry storage needs due to a shift from the 3000 rate to the 1987 rate. *See* PX 500 (Metcalfe Report). The government counters with an assessment by its own expert, Dr. Neuberger, who challenges the methodology of the Metcalfe model and offers an alternative where ANO would load the nine additional casks in the non-breach world. DX 537 (Neuberger Report).

Under the 1987 rate, ANO would have received its initial allocation of acceptance rights in 1999, a full two years earlier than under the 3000 rate. PX 500 at 3 (Metcalfe Report). Notwithstanding the earlier start, the 1987 rate "provides for somewhat fewer cumulative acceptance allocations over the period from 1998 through 2006." *Id.*; *see also* PX 500, Attach. A at ANO008002-8003 (representing ANO's acceptance rights at each unit under the 1987 rate) (Metcalfe Report). In short, although DOE would have removed SNF assemblies from the ANO spent fuel pools sooner under the 1987 rate, a somewhat greater number of assemblies would ultimately have remained in the pools during the claim period than would have been present under the 3000 rate. As a result, assuming that ANO did not load additional casks in the performance world, it would have experienced fuel-core-reserve infringement on one more occasion than it would have under the 3000 rate schedule. 2012 Tr. 61:3-16 (Metcalfe).[18] Plaintiffs submit that this level of infringement and volume of fuel storage is at least equally as plausible as that found reasonable under the 3000 rate, especially in light of the fact that the Metcalfe model projects that the infringements under the 1987 rate would have been in magnitude smaller than those which were actually allowed by ANO in the real world. PX 500 at 3-4 (Metcalfe Report); 2012 Tr. 85:25 to 86:24, 91:21 to 92:17, 94:1-8 (Metcalfe). Infringements at Unit 2 were projected at 62 assemblies in 2002 and only 37 assemblies in 2003. PX 500 at 4 (Metcalfe Report).

The Neuberger model strays from the Metcalfe model in two respects: first, it accounts for Boraflex degradation by assuming that DOE would reserve the same number of cells in the pool for water holes as it did in the breach world, and second, it adopts the convention of imposing full core reserve at the end of each calendar year. 2012 Tr. 1582:24 to 1583:4 (Neuberger); DX 537 at 13-16 (Neuberger Report).

The court finds the restrictions Dr. Neuberger's model places on ANO to be contrary to the evidence and thus unsupported. Although water holes were used by ANO in the actual world to manage Boraflex degradation, it was not the only method available. *See* supra, at 16-17 (discussing the various methods ANO employed to manage criticality and compensate for Boraflex degradation). ANO used a combination of criticality controls to manage the Boraflex problem during the claim period, of which water holes was only one. Furthermore, ANO could have recovered some of the cells which were unavailable in the real world by eliminating heavy load restrictions, repairing damaged cells, or removing unnecessary piping. 2012 Tr. 257:25 to 258:16, 262:4-16 (Walker). In all events, water holes are a secondary consideration because Dr. Neuberger's model is driven primarily by his end-of-year restriction.

[18]Unit 2 would have infringed upon full core reserve two additional times (in 2002 and 2003), but Unit 1 would have avoided one infringement (in 1999) under the 1987 rate compared to the 3000 rate. 2012 Tr. 61:3-16 (Metcalfe).

Dr. Neuberger's second alteration of the Metcalfe model is an imposition of mandatory full core reserve at the end of each calendar year. 2012 Tr. 1582:25 to 1583:1 (Neuberger). This imposition is entirely arbitrary. As demonstrated at trial, ANO performed its refueling at 18-month intervals. 2012 Tr. 189:1-24 (Walker). Prior to a refueling outage, ANO preferred to attain full core reserve. Dr. Neuberger offers no compelling rationale as to why ANO was obliged to attain full core reserve at the end of each year when refueling did not occur, and why he failed to impose it during the mid-year times when it did.[19] By way of explanation, the government points to the general practice and preference at ANO of maintaining full core reserve as evidence that ANO would have held itself to the imposition of full core reserve as modeled by Dr. Neuberger. *See* Def.'s Br. at 29-31. Yet, in the real world, ANO infringed on full core reserve "very frequently," typically directly following a full core offload during a refueling. 2012 Tr. 823:1-14 (McCoy); *see also* 2012 Tr. 195:10 to 196:3 (Walker) (stating that although meeting full core reserve is a goal of ANO, that goal is "hardly ever" met); 92:6-17 (Metcalfe) (noting instances of infringement in the actual world greater than those sustained under his 1987 rate model for the but-for world). Given ANO's real-world willingness and ability to operate with regular full core reserve infringement, the court finds Dr. Neuberger's insistence on a mandatory imposition of a full-core-reserve capacity of the pools at year end to be inconsistent with the facts, and his model to be therefore unconvincing.

The Metcalfe model demonstrates a plausible 1987-rate non-breach world by which ANO could have reasonably continued to operate without loading the nine VSC-24 casks which were loaded into dry storage in the actual world. The government has failed to refute that model, and accordingly, the court finds that the government is liable for the costs of loading the nine VSC-24 casks.

C. *Water Transfer System*

The need to replace the temporary water transfer system with a permanent system was entirely precipitated by the switch from VSC-24 casks to Holtec casks at ANO. As discussed above, the configuration of the temporary water transfer system was incompatible with a Holtec work platform because the structure of the Holtec platform interfered with its piping. 2012 Tr. 633:21 to 634:3 (Supko); 1059:13 to 1060:3 (Williams). The government's witnesses admitted that replacing the temporary water transfer system was a reasonable decision under the circumstances. 2012 Tr. 1385:13-21 (Brewer) ("I think it's eminently reasonable for [ANO] to replace the temporary water [system]."). At the original trial, the court found that under the 3000 rate, plaintiffs established causation between DOE's non-performance and the necessity of installing a permanent water transfer system. *System Fuels III*, 79 Fed. Cl. at 61-62.

The government argues that it should not be liable for the cost of installing permanent water transfer systems because System Fuels would have eventually replaced the temporary water transfer system with a permanent system, even absent the breach. Def.'s Post-Trial Br. at

[19]Additionally, System Fuels presented evidence to the effect that full core reserve is not a requirement for refueling. ANO can perform (and, indeed, has performed) an in-core shuffle or a partial core offload during refueling if the spent fuel pools do not have full core reserve at the relevant time. 2012 Tr. 829:25 to 830:20 (McCoy).

35. This argument is premised not on any assertion that ANO would have had to implement the Holtec system absent the government's breach, but rather on the inherent inefficiencies and inconveniences of the temporary water transfer system, even if used only with the VSC system or with any cask system DOE would have provided. *Id.* This is the same argument the government made without success at the original trial. *See System Fuels III*, 79 Fed. Cl. at 61-62. After the original trial, the court found that "[a]bsent the shift to the Holtec system, the evidence shows that the temporary water transfer system could have been used, albeit with some risk." *Id.* at 62 (citing 2007 Tr. 887:9-19 (Williams) ("The risk . . . to personnel safety aside, the use of the VSC-24 system could have continued to use the temporary water transfer system that was used for a majority of the cask transfers.")).[20] Applying the 1987 rate rather than the 3000 rate does not change this analysis. The government has not elicited testimony or produced evidence sufficient to disturb the causation established at trial in 2007 and reinforced by plaintiffs in 2012. Plaintiffs have shown that, absent DOE's breach, the temporary water transfer system could have, and reasonably would have, continued to be used at ANO.

D. *L-3 Crane*

Plaintiffs claim, and the government contests, damages for the cost of upgrading the L-3 crane at ANO, encompassing an upgrade from 100-ton lifting capacity to 130-ton lifting capacity, as well as making the crane single failure proof. These costs were awarded in the original trial under the 3000 rate based on the fact that the upgrade was needed "[t]o handle the heavier loads associated with use of the Holtec system of casks," the use of which was necessitated by DOE's breach. *System Fuels III*, 79 Fed. Cl. at 60-61. The parties do not dispute the fact that the use of Holtec casks at ANO was caused by DOE's failure to perform at the 1987 rate. Nor do they disagree over whether the upgraded L-3 crane was necessary to accommodate the Holtec cask selected for use at ANO. The government contends now, as it did in the first trial, that ANO would have upgraded the crane even in the non-breach world to accommodate "ANO's need to load hundreds of DOE casks (involving potentially thousands of heavy load lifts)." Def.'s Brief at 39; *System Fuels III*, 79 Fed. Cl. at 61.[21] The government also asserts that ANO could have selected a lighter Holtec cask (rather than the 125-ton cask it selected in the actual world), and claims that a lighter cask could have been modified to meet the weight

[20]The risk to personnel safety primarily arose from the need for ANO's employees to work near the cask loading pit to assemble and disassemble the temporary water transfer system. *See* DX 264 (Unit 2 Water Transfer System History and Condition). The bottom of the cask loading pit was approximately 40 feet below the level of the auxiliary building floor. 2012 Tr. 1280:1-5 (Test. of David Eichenberger, Entergy's Senior Project Manager for Dry Fuel Storage at ANO). ANO recognized the hazard of falls and the need for personnel to use safety harnesses. 2012 Tr. 1132:8-17 (Williams).

[21]ANO would have had to use the preexisting crane to load fuel into DOE-provided casks had DOE performed. Under the Standard Contract, DOE would have been obliged to provide casks suitable for loading using the available equipment and facilities at ANO. *See* DX 1, Art. IV.B.2. (Pls.' Standard Contract) ("DOE shall arrange for, and provide, a cask(s) and all necessary transportation of the SNF and/or HLW from the Purchaser's site to the DOE facility. . . . Such cask(s) shall be suitable for use at Purchaser's site.").

specifications of the 100-ton L-3 crane. *See* DX 552 at SXA036-002808; *see also* 2012 Tr. 1414:11-19 (Brewer); Def.'s Post-Trial Brief at 40.

As after the original trial, the court finds the government's objections to the L-3 crane costs to be unavailing. The loading of DOE casks should not have strained the L-3 crane any more than loading VSC-24 casks, for which the crane was already equipped, because the government was required to bring compatible casks. *See System Fuels III*, 79 Fed. Cl. at 61 ("The original crane was part of ANO's infrastructure, and under the Standard Contract DOE was obliged to provide a cask suitable for use at ANO."). The suitability clause of the Standard Contract would have required DOE to bring a cask roughly equivalent to the VSC-24 for which it was equipped, *i.e.*, weighing less than 100 tons and capable of withstanding a drop from the non-single failure proof L-3 crane. The old L-3 crane could have loaded VSC-24-equivalent casks without any further upgrades. *See* 2012 Tr. 623:22 to 624:1 (Supko).

Once ANO switched to Holtec casks, the single failure proof upgrade became a necessity. *See* 2012 Tr. 622:1-18 (Supko) ("[T]he [Holtec] system couldn't be shown with a cask drop analysis to be able to meet the requirements for which the transfer cask is certified. . . . So if you can't drop the package then you have to have a single failure proof crane."); *see also* 2012 Tr. 1044:21 to 1045:4 (Williams). The government's assertion that ANO could have avoided the increased capacity upgrade by selecting the lighter Holtec cask is not sound. The 100-ton cask offered by Holtec, the HI-TRAC 100, carried the same number of SNF assemblies as the one ultimately selected by ANO, but it lacked the same level of radiation shielding as the heavier cask. 2012 Tr. 1148:14-23 (Williams). ANO's selection of the heavier HI-STORM model was reasonable given the safety concerns inherent in using a less shielded cask.

ANO was by no means required to select the method of mitigation most favorable to the government at the cost of endangering its own employees. *See Ketchikan Pulp Co. v. United States*, 20 Cl. Ct. 164, 166 (1990) ("[The non-breaching party] is not required to make extraordinary efforts to ferret out the single best situation which will absolutely minimize the breaching party's damages."). Consequently, System Fuels' selection of the HI-STORM over the HI-TRAC 100 was a reasonable step after DOE's non-performance necessitated the addition of more dry storage at ANO. The government is not entitled to a reduction in damages for this reason.

In a final effort to escape some measure of damages related to the L-3 crane, the government argues that certain ancillary features of the upgrade were both unrelated to the breach and unduly beneficial to ANO. *See* Def.'s Post-Trial Br. at 41. These features include remote controls to operate the crane, a motorized crane hook, and an increase to the crane's auxiliary hook capacity. *Id.* Both parties agree that these features were "almost a universal modification" at the time the L-3 crane was upgraded. *See id.*; Pls.' Post-Trial Br. at 44; 2012 Tr. 1405:8-25 (Brewer). The government attempts to sidestep responsibility for the cost of these modifications by arguing that "the addition of these other features was caused by [System Fuels'] decision to upgrade the crane to single failure proof, rather than by DOE's delay." Def.'s Post-Trial Br. at 41. This view of causation is unduly constrained. In making this argument, the government conveniently ignores the fact that, but for its breach, the decision to upgrade to single failure proof would never have been made. Plaintiffs have demonstrated with reasonable

certainty that the L-3 upgrade could reasonably have been avoided if DOE had performed, and thus they are entitled to full recovery for the costs of that upgrade.

E. *Avoided Costs*

On remand, the government contends that System Fuels must account for a lengthy list of enumerated costs avoided, and that the court must deduct such avoided costs from plaintiffs' damages. Def.'s Post-Trial Br. at 44-50; *see also Southern Nuclear Operating Co. v. United States*, 637 F.3d 1297, 1304 (Fed. Cir. 2011) ("[W]ith respect to both claimed costs and avoided costs, plaintiffs bear the burden of persuasion . . . [, but] the government must identify the nature of the avoided costs in question on remand."). A two-step process is involved. The government bears the burden of identifying the costs avoided, after which the plaintiff has the burden of incorporating those costs into its but-for formulation. *See Southern Nuclear*, 637 F.3d at 1304. The allegedly avoided costs in this instance can be grouped into three distinct categories: (1) costs associated with continued maintenance of Boraflex; (2) costs associated with periodic assembly and maintenance of the temporary water transfer system; and (3) costs associated with the use of a non-upgraded L-3 crane. Because the court has declined to award plaintiffs any damages associated with Boraflex, *see* supra at 17, no reduction in award need be made due to avoided costs in that area. Therefore, only costs related to the temporary water transfer system and the L-3 crane remain at issue.

1. *Avoided costs associated with replacement of the temporary water transfer system.*

The government contends that System Fuels avoided $1.8 million in costs by installing the permanent water transfer system, because it obviated the need to assemble and disassemble the temporary system with each cask loading for the rest of the plant's entire life. Def.'s Post-Trial Br. at 49. The government's number is derived by estimating the cost of the man hours spent on each installation and removal and multiplying that cost by the estimated number of casks which would be loaded over the entire remaining permitted life of the ANO plant plus its decommissioning period. DX 536 at 7 n.14 (Brewer Report).

The government's suggested calculation of avoided costs is inapt. It rests upon multiple unwarranted assumptions reaching far beyond the claim period. First and foremost, it assumes that ANO will continue to operate through the expiration of its operating license and that the decommissioning period can now be ascertained. It also assumes that dry storage strategies at ANO will not shift over the coming years and that cask loading rates will remain predictable. The government, however, is not entitled to make these assumptions. The calculation of costs avoided over the course of a lifetime are nothing short of wild speculation on the part of the government. The court declines to provide an offset to plaintiffs' damages based on such projections.

While the court cannot award a speculative offset as suggested by the government, the fact remains that System Fuels indeed experienced some certain financial benefit by avoiding the cost of assembling and disassembling the temporary water transfer system while loading of Holtec casks during the claim period. ANO loaded 22 Holtec casks through the end of the claim period, each of which used the permanent system rather than the temporary system. *See System*

Fuels III, 79 Fed. Cl. at 58 n.22. ANO did not have to install and then remove the temporary system for these loads because, as explained, the Holtec casks required ANO to provide and use a replacement permanent water transfer system compatible with the Holtec work platform. The court therefore finds that for these 22 cask loadings, ANO did avoid costs unique to the temporary water transfer system, which should be deducted from plaintiffs' overall award of damages.

The government has formulated a methodology for calculating the avoided costs associated with the temporary water transfer system, and plaintiffs have neither refuted that methodology nor objected to it. Under the government's system, each cask loading using the temporary system cost System Fuels $2,560. DX 536 at 7 n.14 (Brewer Report).[22] Because ANO loaded 22 casks without the extra burden of assembly and disassembly during the claim period, a total savings under this formula amounts to $56,320. The court accordingly holds that plaintiffs' damages should be reduced by that amount of avoided cost.

2. *Avoided L-3 crane costs.*

The government argues that having upgraded the L-3 crane, ANO now avoids the ongoing costs of additional labor for cask loadings, as well as the expense of a cask drop analysis and other mitigation costs. Def.'s Post-Trial Br. at 49. No quantification of these costs was provided during the remand trial.

The additional labor cited by the government presumably refers to personnel who "spotted" the L-3 crane as it lifted and lowered casks through blind spots where the operator's view was obscured. *See* 2012 Tr. 1152:3 to 1153:3 (Williams). The upgraded L-3 crane featured a wireless remote control, which could have enabled a crane operator to control the crane from locations where such blind spots would no longer pose an issue. 2012 Tr. 1153:8-12 (Williams). Nonetheless, "procedures would require a spotter or a second person" despite the crane operator's increased mobility. 2012 Tr. 1153:18-19 (Williams). Consequently, no avoided costs of that type were realized.

As to expenses of cask drop analysis and other mitigation costs, these are costs which would arise almost entirely on a one-time basis and had already been incurred at the time the claim period expired. Cask drop analysis need only be performed when a new type of "heavy load" (*i.e.*, a new cask type) is used, *see* 2012 Tr. 1356:19-24 (Brewer), and ANO had already evaluated the Holtec casks during the claim period, 2012 Tr. 451:4-15 (Walker). Mitigation costs in the form of impact limiting materials had also previously been incurred by ANO when they initially constructed these materials. Any continued cost related to the impact-limiting materials was related purely to the amount of time it took to assemble or stage them prior to

[22]This number was reached by assuming that each installation or removal required one supervisor and three additional employees and took eight hours at $40 per hour for each employee. This formula yields a cost of $1,280 for each installation or removal. Since each cask loading could have required both an installation and a subsequent removal unless several casks were loaded during one session, the total cost of each cask load would be $2,560. DX 536 at 7 n.14 (Brewer Report).

loading. 2012 Tr. 1358:8 to 1359:17 (Brewer). This time was *de minimis*, and the court will not postulate a nominal value. Therefore, the court finds that the government is not entitled to a decrease in damages due to costs saved related to the L-3 crane upgrade.

CONCLUSION

For the reasons stated, the court finds that plaintiffs have established to a reasonable certainty that, but for DOE's breach, it would not have incurred costs for three of the four disputed mitigation categories considered at the remand trial, in addition to the $34,051,573 which was not disputed by the parties.[23] Accordingly, System Fuels is entitled to its claimed damages for the cost of upgrading its L-3 crane (amounting to $3,291,974), the cost of installing a permanent water transfer system at ANO (amounting to $1,415,847), and the cost of all additional dry storage casks past the first fifteen VSC-24 casks (amounting to $9,110,424). The court finds that the government's breach was not a but-for cause of the Boraflex degradation at ANO, and therefore does not award the $4,105,842 of damages claimed for the costs associated with mitigating that product failure. The court awards an offset in the amount of $56,320 for the costs which plaintiffs avoided by mitigating the government's breach. The total damages awarded plaintiffs are $47,813,498. The Clerk shall enter final judgment for plaintiffs in that amount.

In accord with the *Restatement (Second) of Judgments* § 26(1)(b) and (e), plaintiffs shall retain the right to bring subsequent actions on claims for damages incurred after June 30, 2006.

The court awards costs for plaintiffs in accord with RCFC 54(d).

It is so ORDERED.

s/ Charles F. Lettow
Charles F. Lettow
Judge

[23]The amount not in dispute includes capital suspense loader costs of $4,323,930,which were not originally awarded by the court but which were ordered to be awarded by the court of appeals. *See System Fuels V*, 457 Fed. Appx. at 935-36.